Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

FPM Report NE98-2 **February 4, 1998**

Insect and Disease Conditions at Headquarters Area and Manzanita Lake Campground, Lassen Volcanic National Park

Bill Woodruff
Plant Pathologist

Sheri Smith
Entomologist

Gregg DeNitto
Plant Pathologist

David Schultz
Entomologist

Introduction

At the request of John Arnold, Forester at Lassen Volcanic National Park, USFS Forest Pest Management (FPM) evaluated the insect and disease conditions at the Headquarters Area and Manzanita Lake Campground on May 13-14, 1997. The objective of this evaluation was to identify hazard trees, determine insects and diseases associated with tree decline, and identify management alternatives which Park managers can use in developing vegetation management plans for these two sites.

We made observations on hazard trees that were encountered and provided that information in an earlier report "Hazard trees in Headquarters Area and Manzanita Lake Campground in Lassen Volcanic National Park" on May 30, 1997. We did not do a complete hazard tree survey and only noted those we observed during our field evaluation. The Park staff should perform detailed hazard tree surveys to locate any remaining dangerous trees and to develop a hazard tree management plan for the Park. FPM can provide technical information and advice on hazard tree management.

HEADQUARTERS AREA

Observations

The Headquarters area is occupied by a typical mixed conifer stand that has not had any recent disturbance other than tree removals for human occupancy and safety. There are scattered large predominant ponderosa pines, sugar pines, incense-cedars, and white firs overtopping a layer of primarily white fir and incense-cedar. Understory vegetation is not common. Much of the Headquarters Area vegetation is existing in an overstocked condition.

Three dominant site trees were measured to aid in determining the quality and productivity of the site. Specific data are given in the table below. The last ponderosa pine in the table is growing next to the irrigated lawn near the old Superintendent's Office. Its rate of growth is an indicator of the capability of the site for conifer growth when an abundance of moisture is available. Young trees can grow very large in a short time if adequate moisture is available and competition from surrounding trees is minimized.

The site information is summarized below:

Species	Age	Height	dbh	Site Index
PP	135	170'	43"	80
SP	126	170'	45"	90
WF	135	130'	19"	65
PP	54	100'	20"	100

Stand density (stocking) was sampled at eight points in the Headquarters Area. Basal areas of 200, 220, 240, 340, 360, 380, 500, and 520 square feet per acre were measured. For this type of stand and site the "normal" or fully stocked stand has a basal area of 344 sq.ft./ac. At this level and above some tree mortality can be expected to be initiated. Half of the points measured were overstocked (greater than "normal").

The following bark beetles were identified:

Scolytus ventralis, fir engraver, in white fir;
Dendroctonus ponderosae, mountain pine beetle, in sugar pine;
Dendroctonus valens, red turpentine beetle, in sugar pine.

The following forest pathogens were identified:

Heterobasidion annosum, annosus root disease, in a windthrown white fir (delaminated wood in roots, no conks found for positive identification);
Phaeolus schweinitzii, "velvet top" fungus, in an old ponderosa pine;
Dwarf mistletoes:
Arceuthobium campylopodum, in ponderosa pine;
A. californicum, in sugar pine;
A. abietinum f.sp. concoloris, in white fir;
Phoradendron libocedri, true mistletoe on incense cedar;
Gymnosporangium libocedri, incense-cedar rust;
Peridermium harknessii, western gall rust on ponderosa pine;
Cronartium ribicola, white pine blister rust on sugar pine.

The following mechanical damage was noted:

Numerous broken tops on pine and fir in old and young trees;
Windthrown white fir trees with annosus root disease;
Fire scars on the old ponderosa pine and incense-cedars;
Bole decay encouraged by sprinkler irrigation.

Discussion

A discussion of specific forest diseases can be found in Agriculture Handbook 521, Diseases of Pacific Coast Conifers (copy given to John Arnold). Insect biologies are a included at the end of the report. All of the above insect and disease conditions are currently at low (endemic) levels.

As stated above, much of the forest in the Headquarters Area is overstocked. There are two consequences of this condition. One is that mortality can occur resulting in the loss of desirable individual trees or species. This is a result of competition for limited resources and the weakening of the trees. Opportunistic organisms, such as bark beetles and wood borers, can then successfully attack these trees and kill them. The second consequence is that the risk of catastrophic wildfire is greater.

The natural condition of these forests can be envisioned by examining the current size and age class distribution of trees and the remnants of stumps. Trees greater than 150 years of age are few and generally scattered. Most of them are pines with a few incense-cedars and white firs. The majority of the stocking in stems from this age class is not made up of white fir and incense-cedar, both shade-tolerant species that tend to be susceptible to fire damage in their earlier years. It is probable that the fire regime present prior to European settlement reduced the amount of this ingrowth and resulted in less competition and better growing conditions for the larger, shade-intolerant overstory trees.

Management Alternatives

Alternative 1 - No action except hazard tree removal

Currently, minimal vegetation management is conducted in the Headquarters Area. Unsightly or hazardous dead trees are removed and trees are cleared to make space for construction. Windthrown trees which are unsightly or "in the way" are also removed. No thinning is being conducted to reduce stand densities. Many areas are fully or overstocked with trees. In time, tree densities will increase, leading to a higher incidence of bark beetle related mortality. Ponderosa and sugar pines are the species most likely to be attacked. Tree mortality is leading to fuel build-up which increases the chances that accidental and more severe fires will occur in the Headquarters Area. A serious fire threat exists in the dense forest that closely surrounds the homes and other buildings. A wildfire burning into the area from the surrounding forest may be impossible to control as the flames spread through the continuous canopy. In such a situation, most trees could be killed and many structures destroyed.

Alternative 2 - Proactive hazard tree management

Twenty-four hazard trees were identified and reported to Park officials in a previous report (see FPM report #NE97-5, dated May 30, 1997). These hazard trees were found without intensive searching. A comprehensive hazard tree exam would likely identify more such trees.

Hazard trees pose a threat to people and property. Establishment of a hazard tree management program in the Park would reduce the possibility of human injury and property damage associated with tree failures. If hazards were identified and removed annually, the hazard tree management program would not be overwhelming in any one year. Documentation of hazard trees would provide a database to track trees through time and document changes in condition from year to year.

Alternative 3 - Thin the trees to promote tree vigor and growth

By keeping the trees in Headquarters at 80% or less of "normal" (ie. at approximately 275 sq.ft./ac. basal area or less), the risk of significant levels of bark beetle related mortality can be minimized. When planning such thinning, it should be recognized that this is an average to be applied across the landscape and some variability may be desired. Individual trees of particular merit, such as mature pines, may benefit by having the stocking around them reduced to lower levels. Other areas with less valuable individual trees may tolerate higher stocking levels, especially if the main species is white fir. It must be recognized that these trees will not grow as fast. In addition to reducing tree stress, thinning, especially of the understory, will somewhat reduce the risks and damage from any fire that might occur and provide a more defensible space if the activity fuels are treated. Also, thinning will decrease the continued need to enter stands for salvage and hazard tree removal.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189
Some of the areas around the Headquarters have few large trees. By reducing the intertree competition, the growth of the remaining trees will be accelerated and provide a mature stand faster. In many areas there is little or no regeneration. Some planning for regeneration is advised to provide replacement trees in the future. This may require the creation of small openings to get survival and growth of the shade intolerant species, ponderosa and sugar pine.

Alternative 4 - Create a fire defensible area

Thinning performed for fire protection would remove many more trees and
open up the forest much more than Alternative 3. This thinning would also result in vigorous tree growth, thus the remaining trees would be better able to resist insect and disease attacks. Thinning to lower stocking levels would reduce the ladder fuels that currently exist. Because of the stand age, it may be advisable to plan such a reduction in two or more stages so that the residual trees are not adversely affected by the increased light and decreased physical support from their neighbors. It is still wise to leave some young healthy trees to grow as replacements for the large trees. Young open grown trees will grow fast and provide replacements for the old growth trees when they die.

In providing fire protection for Headquarters Area, it is also a good idea to work with adjacent land-owners. Surrounding forests could be thinned to enhance the fire protecting efforts performed in the Park.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

MANZANITA LAKE CAMPGROUND

Observations

Manzanita Lake Campground is situated in a Jeffrey pine stand of very large widely spaced conifers with little pine reproduction and much manzanita brush and white fir in between. Most of the Jeffrey pine in the campground are old and heavily infested with elytroderma disease. Some pine west of the Lake and in Loop F are infested with dwarf mistletoe. White fir, historically a small component of the forest, has established itself in large numbers among the pine over the last century. Much of the pine forest is now crowded with mature white fir or manzanita which are competing with the pine for moisture.

Following the protracted, below normal precipitation period between 1987 and 1994, many Jeffrey pine were killed by bark beetles when the trees were stressed by overcrowding (See FPM Report NE95-15). The dead/dying trees and their stumps have since been removed. Currently FPM personnel assist the Park with annual surveys to detect Jeffrey pine beetle infested trees. Infested trees are removed on an annual basis prior to beetle emergence. It is important to continue promptly removing Jeffrey pine that become infested to prevent beetle buildup in and around the campground.

Tom Warner, et al., determined the site index for Manzanita Lake Campground in the report "Tree Hazard Evaluation, Manzanita Lake, Lassen Volcanic National Park", dated April 12, 1996. According to the report, the Dunning (1933) site indices for Jeffrey pine and white fir are 60 and 70, respectively, which correspond to the Region 5 Forest Service Site Class 2. Warner stated that the recommended maximum stocking for this area is 264 sq.ft./ac. We sampled stand density (stocking) at four points in the campground. Basal areas of 320, 380, 520 and 520 square feet per acre were measured. The latter two densities were in areas where white fir had become established.

The following forest insects were identified:

Dendroctonus Jeffreyi, Jeffrey pine beetle, in Jeffrey pine;
Scolytus ventralis, fir engraver, in white fir; -

The following forest diseases were identified:

Elytroderma deformans, Elytroderma disease on Jeffrey pine;
Arceuthobium campylopodum, western dwarf mistletoe on Jeffrey pine; Heterobasidion annosum, Annosus root disease in white fir;
(delaminated wood, no conks found for positive identification);

The following mechanical damage was noted:
Broken tops on old pine and fir;
Fire scars on the old Jeffrey pine;
Bole decay in some of the fire scars.

Discussion

One of the management objectives within Manzanita Lake Campground is to maintain Jeffrey pine as a component of the forest with particular emphasis on keeping the large, old Jeffrey pine.

Over the past few years Jeffrey pine beetle has been the most important agent, in terms of causing tree mortality, in the campground. Jeffrey pine beetles typically kill "groups" of trees and create large openings which are usually not desired in a campground. Jeffrey pine beetle related impacts can be minimized by a proactive infested tree removal program and by reducing intertree competition by thinning out the dense understory. Although fir engraver beetles can be implicated in the white fir mortality in the campground, the level of mortality observed is not above background levels. Thinning will promote the health and vigor of the residual vegetation and should reduce the amount of mortality occurring in this species.

The elytroderma disease is heavy in many Jeffrey pine trees. This is most likely due to the microclimate (high relative humidities) around the lake. Elytroderma can have a significant effect on tree growth and survival when infection levels in individual trees are high. No control, other than tree removal, is known for elytroderma. Reducing other stresses, such as overstocking, may allow trees to tolerate higher levels of infection. Heavy dwarf mistletoe infestations are present in a few Jeffrey pine west of the lake, and in, and north of Loop F.

Like dwarf mistletoe, elytroderma disease infects a pine branch and causes an abnormally profuse, dense mass of branches to grow; this is called a "witches' broom". There are many very large witches' brooms growing on the Jeffrey pine in Manzanita Lake Campground. A very large witches' broom will sometimes dislodge from a tree, especially when loaded with snow. In some situations, a witches' broom will not fall from the tree, but remain hanging into the use season. When this happens, people under the trees may be at risk. Having tables, parking pads, etc. under large brooms creates a hazardous situation. Large witches' brooms should be pruned from the trees to remove the danger.

In addition, heavy infestations of either elytroderma or dwarf mistletoe weaken the pine and predispose them to bark beetle attack. Some of the Jeffrey pine are heavily infected and have a higher risk of mortality. Dwarf mistletoe witches' brooms can be pruned from lightly infected trees to increase the life of the trees. Since dwarf mistletoe can infect healthy pine within 25-50 feet, infected pines should not be grown near uninfected pines or over pine regeneration.

Hazard trees are a concern in Manzanita Lake Campground because of the high proportion of large, old pine trees. Trees with root and stem rot, multiple tops, excessive lean, etc. are often dangerous to leave near where people camp or gather. A list of hazard trees was provided in FPM report #NE97-5, on May 30, 1997. Managers should remedy hazardous conditions as they are discovered. Hazard tree surveys should be conducted annually in the campground before it is open to the public.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

One important management consideration in the Manzanita Lake area is the lack of young pine in the understory. Without an understory, there will be no pine to replace the old Jeffrey pine trees as they die. Pine regeneration needs to be encouraged in openings where adequate sunlight penetrates and there is a lack of competing vegetation. Many of the openings created by the recent removal of Jeffrey pines can be planted to provide this recruitment. Nearby dwarf mistletoe infected pine should be removed to keep the young pines free of the disease.

Vegetation Management Alternatives

Alternative 1 - No action except hazard tree removal

Continued lack of management beyond hazard tree and Jeffrey pine beetle infested tree removal will likely result in additional mortality over time. Jeffrey pine beetle attacks will be exacerbated during protracted drought periods which will result in more unplanned/unwanted openings. Stocking levels will continue to increase and the white fir component will continue to replace the Jeffrey pine trees. Lack of management will continue to promote an understory of white fir instead of the more desired pine. There will be a higher risk of stand replacing fire. Elytroderma and dwarf mistletoe infestations will continue to increase in severity and weaken pine trees so that they are more susceptible to bark beetle related mortality. Hazard trees will occur at a higher level as a result of the bark beetle infestations.

The current stand density poses a threat to the maintenance of long-term forest cover in the area. A large number of encroaching white fir are present and using moisture needed by the Jeffrey pine for survival. These overstocked areas are susceptible to insect and disease problems for both the pine and fir. Stressed trees in these overstocked stands will continue to attract bark beetles which can kill the stressed trees as well as nearby trees. Infestations happen with little warning.

Alternative 2 - Proactive hazard tree management

During this FPM exam, 26 hazard trees were identified in Manzanita Lake Campground and reported to Park officials (See FPM report # NE97-5, dated May 30, 1997). A comprehensive hazard tree survey needs to be conducted annually by Park officials to locate trees that may likely fail and identify mitigation measures. Hazards may include large witches' brooms, dead tops, broken and hanging branches and trees with excessive lean and/or advanced root or stem decay. Hazardous trees should be made safe each season prior to opening the campground.

Alternative 3 - Manage vegetation to promote tree vigor and reduce fire risk

When the Lassen Volcanic National Park was established, the open forest in and around Manzanita Lake Campground was more resistant to bark beetles because there was little competition for moisture from brush and nearby trees. Also, the open forest could resist stand replacing wildfires. Fire exclusion has allowed white fir and brush to spread throughout; creating competition for the pine and ladder fuels for wildfire. Park managers have the opportunity to recreate an open grown forest by thinning the trees in the campground and removing or burning

some of the competing brush. An open stand will improve tree vigor and resistance to the effects of bark beetles and disease. Young pine can become established in the created openings.

By keeping the trees in Manzanita Lake Campground at or below the recommended stocking, the risk of losing many of the large, older trees, especially Jeffrey pines, is reduced. According to Tom Warner, et al, in his April 12, 1996 report, the recommended stocking is 264 sq.ft./ac. basal area.

One factor to consider when determining desired stocking level is the amount of brush that is present. Manzanita is growing amongst the trees in Manzanita Lake Campground. The manzanita uses soil moisture which the conifers could use to maintain vigor. Where dense brush is present, conifer stocking should be something less than 264 sq.ft./ac. Alternatively, the manzanita could be removed to improve the survival of the pine and to provide openings for natural or planted pine regeneration.

Another factor to consider is the management objective (recreation) of the area. Since visual considerations are more important in campgrounds than growth and vigor, adjustments around the recommended stocking level could be made for specific sites. Managers need to realize the trade-offs. The old Jeffrey pine cannot compete for the water/nutrients as well as the younger white fir. Mortality levels will fluctuate with precipitation and will increase when protracted dry periods occur. An increase in mortality levels equates to more hazard trees, more unwanted openings, and reduces the options for campground management.

The dwarf mistletoe in Jeffrey pine may be addressed where dwarf mistletoe levels are high. This includes pruning of individual witches' brooms from trees that have low to moderate levels of infection, regeneration of non-hosts around infected trees, removal of heavily infected trees, and separation of infested areas from non-infested areas by species manipulation.

Regeneration should be started in areas where the Jeffrey pine were killed. Planting of a mix of tree species, but favoring Jeffrey pine, would be done to provide future cover in these areas. Other areas may also benefit from regeneration efforts to provide future replacement trees. These areas may need to have lower stocking levels maintained to encourage growth of the regeneration. Protection of the regeneration after establishment is a necessity in campgrounds.

CONCLUSION

The biggest factor affecting conifer health in both Headquarters and Manzanita Lake Campground is the stocking level. Many additional trees have seeded in and grown amongst the large open grown conifers that were present when the Park was established. When too many trees grow in an area, many of them become stressed for lack of soil moisture, nutrients and sunlight. When trees are stressed they are susceptible to bark beetles, root disease, and other organisms that can kill trees.

Another condition to consider is the old age of many of the trees in both areas. Old trees are often damaged over the years by storms, weather, animals and human activities and often become hazardous to people and property. A hazard tree management program needs to be established to proactively remove dangerous trees and conditions.

Old trees eventually die. In parts of Headquarters Area and in most of Manzanita Lake Campground, very few young pine exist to replace the old ponderosa and Jeffrey pine when they die. It is time to start cultivating replacement trees if managers wish to maintain pine in these areas.

For both Headquarters area and Manzanita Lake Campground, the action alternatives applied in combination, should result in lower levels of bark and engraver beetle mortality, an increase in growth and vigor in most trees, lower the risk of injury and/or damage resulting from hazard trees, reduce the risk of catastrophic fire, and ensure that pine is a component in these ecosystems in the future.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

INSECT BIOLOGY:

Jeffrey Pine Beetle, Dendroctonus jeffreyi

The Jeffrey pine beetle is the principle bark beetle found attacking Jeffrey pine, which is its only host. It is a native insect occurring from southwestern Oregon southward through California and western Nevada to northern Mexico. The beetle normally breeds in slow-growing, stressed trees. The beetles prefer trees which are large, mature, and occur singly rather than in groups. Yet when an epidemic occurs, the beetle may attack and kill trees greater than 8 inches in diameter, regardless of age or vigor. Often the beetle infests lightning-struck or wind-thrown trees, but does not breed in slash.

Evidence of Attack

Presence of the beetle is usually detected when the foliage changes color. The color change of the foliage is related to the destruction of the cambium layer by the beetle. Generally, the top of the crown begins to fade in a slow sequence, with the needles turning from greenish yellow, to sorrel, and finally to reddish brown. By the time the tree is reddish brown, the beetles have usually abandoned the tree. Another sign of beetle attack is large, reddish pitch tubes projecting from the bark of the infested tree. If examined carefully, pitch tubes can be detected on infested green trees prior to crown fade. Jeffrey pine beetles have a distinctive "J" shape egg gallery pattern on the inner bark. Larval mines extend across the grain and end in open, oval-shaped pupal cells.

Life Stages and Development

The Jeffrey pine beetle is one of the larger pine bark beetles in California. The beetle has a 4 life stages, egg, larva, pupa, and adult. The adults are stout, cylindrical, black, and approximately five-sixteenths of an inch long when mature. The egg is oval and pearly-white. The larva is white, legless, and has a yellow head. The pupa is also white but is slightly smaller than the mature larva. The life cycle is normally completed in one year in the northern part of the range, but in the southern part, two generations per year may occur. The principle period of attack is in June and July, but attacks also are frequent in late September and early October. Similar to other Dendroctonus species, Jeffrey pine beetles use pheromones that attract other beetles to a tree, causing a mass attack that tends to overcome the tree's natural resistance. Blue stain fungi are associated with Jeffrey pine beetle attacks and aid in overcoming the tree.

Conditions Affecting Outbreaks

Normally the Jeffrey pine beetle is kept in check by its natural enemies, climatic factors, and the resistance of its host. Similar to other Dendroctonus species, the availability of suitable host material is a key factor influencing outbreaks. Healthy trees ordinarily produce abundant amounts of resin, which pitches out attacking beetles. When deprived of moisture, trees cannot produce sufficient resin flow and they become susceptible to successful beetle attacks.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

INSECT BIOLOGY:

Mountain Pine Beetle, Dendroctonus ponderosae

The mountain pine beetle attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. Besides having pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Infested trees can also have boring dust, but not pitch tubes. This may be common in drought years when trees produce little pitch. Attacking beetles carry with them the spores of blue stain fungi. As the fungi develop and spread throughout the sapwood, they interrupt the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the tree to die and the needles to discolor.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is the general rule, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long vertical egg galleries and lay eggs in niches along the sides of the gallery. The hatching larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with think phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include low winter temperatures, nematodes, woodpeckers and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and mortality increases.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

INSECT BIOLOGY:

Fir Engraver, Scolytus ventralis

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and otter sapwood of the bole, thereby girdling the tree. Trees greater that 4 in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without first killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem, usually in areas that are greater than 4 inches in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks. However true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes that are often formed when bark beetles attack pine are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part all of the bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry a brown staining fungi, Trichosporium symbioticum, into the tree which causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those which have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality however attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a

contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Lat 40.93390 Lon -121.60356 and Lat 40.34667 Lon -121.61189

File Code: 3420
Date: February 4, 1998

Marilyn Parris, Park Superintendent
Lassen Volcanic National Park
PO Box 100
Mineral, CA 96063

Dear Ms. Parris:

Enclosed is an evaluation of the insect and disease conditions and general forest health of the vegetation in the Headquarters area and Manzanita Lake Campground in Lassen Volcanic National Park (FPM Report NE98-2). This report is based on a field examination of these areas last May by Forest Pest Management personnel, US Forest Service, in cooperation with John Arnold from the Park. A previous report was sent to you concerning potential hazard trees in both of these areas.

In general, the levels of insect and pathogen activity in these areas are low. The impact of these injurious agents is currently minimal, although some of them may be aggravated by existing stand conditions. The forest stands in both areas are at or above their long-term carrying capacity for the site. More vegetation is on the site than can be sustained, especially during protracted drought periods. The effects of such overstocking was recently demonstrated in Manzanita Lake Campground where many Jeffrey pines were successfully attacked and killed by Jeffrey pine beetle. These trees were less competitive than the understory white fir and were unable to maintain their defenses against bark beetle attack. The overstocked condition is widespread throughout the Headquarters area and in much of Manzanita Lake Campground where forest cover remains. Overstocking such as this will result in a forest that can not sustain large, mature trees. Manipulating the vegetation, both trees and shrubs, can reduce the level of stocking and result in a sustainable forest that meets desired objectives.

Additional site evaluations of other developed areas of the Park are being planned for this year in cooperation with your staff. If you have any questions about this report and our findings, please contact Bill Woodruff or Sheri Smith at (530) 257-2151.

BILL WOODRUFF
Plant Pathologist
Forest Pest Management

Enclosure
cc: John Arnold